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EVALUATION OF ERTS-1 IMAGERY IN MAPPING AND MANAGING  
SOIL AND RANGE RESOURCES IN THE SAND HILLS REGION OF  
NEBRASKA

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16. Abstract Collection of ground truth data provided ground cover percent and the components of ground cover madeup. Percent bare soil appears to have greatest influence on imagery density of sites studied. Forage density estimates can be made on band 5 of MSS, provided site category identification is known. Additional data are provided concerning forage density and vegetation - soil relationship by color composites of MSS imagery. Reflectance differences shown on MSS bands 6 and 7 by Sandhills lakes are related to water quality and possibly more specifically to total dissolved ions present in the water. Winter imagery with snow cover and low sun angle shows a marked enhancement of topography in the sandhills. Subdivisions of sand dune topography are associated with differences in forage density. High altitude aircraft color infrared photography appears to be a usable tool for recognition, measurement and evaluation of "go-back" land.			
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Figure 2. Technical Report Standard Title Page

## Preface

This report covers the period January 1, 1973 to June 30, 1973 for the investigation evaluating the use of ERTS-1 imagery in mapping and managing soil and range resources in the Sand Hills region of Nebraska (MMC 020, James V. Drew, Principal Investigator, GSFC Identification Number UN-062, NASA Contract Number NAS5-21756).

Collection of ground truth data from previously selected range sites was begun during the latter part of the period covered by this report. Data will provide a listing of plant species present, percent of total plant population represented by each species, percent ground cover represented by growing plants, percent ground cover represented by dead vegetation and percent of site which is bare soil. Forage density data for each site are also obtained by clipping of 1 square meter plots and recording of fresh weight and dry weight of samples obtained. Additional documentation in the form of 35mm color and color infrared photography is also taken at the time of collection of ground truth.

Evaluation of band 5 of ERTS 1 imagery with regard to forage density has shown measurable differences in image density where known forage density differences exist on the range sites displayed by the image. Densitometer measurements show approximately 0.1 optical density unit difference between sub-irrigated, sandy and sands-choppy sands range sites, the readings being taken on sites of the same relative forage condition class. However, overlap of optical density values for different site categories with differing forage condition classes does not allow assigning a given forage density value for a given densitometer value unless the range site category is known.

Initial evaluation of color composites generated from bands 4, 5 and 7 of the MSS imagery on the projector-viewer show that the subirrigated range sites can be readily separated from other range sites. This separation delineates soil subgroups Aquic Haplustolls and Typic Haplaquolls from other soil subgroups present in the Sandhills. Diazochrome color composites, with less problem in registration of bands, provide the same site separation and soil subgroup delineation.

Reflectance differences shown on MSS bands 6 and 7 by Sandhills lakes are being investigated. Analysis of water samples to date indicate, generally, that the greater the total amount of ions present in the water, the greater the reflectance, especially band 6. Additional documentation, in the form of field observations of aquatic vegetation and 35mm color and color infrared pictures are also being taken. Densitometer measurements of imagery of MSS band 7 would indicate a division of lakes into two general categories, while measurement of band 6 would indicate three general categories. At this time there is no obvious indication from the data as to what parameters are responsible for division into the various categories.

Winter imagery with snow cover and low sun angle show a marked enhancement of dune patterns. Topographic changes in landscape or frequency of dune pattern are most evident. Comparison of MSS band 5 summer imagery and the identical snow cover area shows that where major dune patterns are composed of many smaller dunes, forage density is significantly less and there is a much greater proportion of active wind erosion.

Cooperation with the Texas A & M Great Plains Corridor project (MMC 667) has provided continued field observations and forage density measurements from the Sandhills test site.

Evaluation of high altitude aircraft photography has been initiated to determine if previously tilled areas of the late 1800's and early 1900's can be recognized, measured, and evaluated for plant cover.

## Introduction

This report describes specific areas of imagery evaluation and supporting ground truth collection during the period January 1, 1973 to June 30, 1973 for contract NAS5-21756. Areas of activity include (1) collection of ground truth from selected range sites, (2) imagery evaluation with regard to estimation of forage density, (3) evaluation of color composite imagery for relationship of vegetative patterns to soil mapping units, (4) analysis of water quality in Sandhills lakes as related to reflectance differences on imagery, (5) study of snow cover imagery in relation to topographic changes in landscape and their effect on forage density, (6) cooperation with Texas A&M Great Plains Corridor project and (7) evaluation of high altitude aircraft photography for recognition, measurement and plant cover characterization of "go-back" land.

## Ground Truth Collection

Collection of ground truth data from previously selected range sites was begun in June, 1973. Current efforts are directed at obtaining a species list and an estimate of bare soil, dead vegetation and live vegetation present on each site. The species inventory will also provide an estimate of the percent of the total plant population represented by each species.

The species list, percent dead vegetation, percent live vegetation, and percent bare soil are obtained by taking 400 sampling points for each site with the focal point apparatus. A series of 20 points are taken at 20 different spots within the site, these spots determined by a rope and compass system originating at a center stake. Identification of each point is recorded and calculations made on summaries of points for the site. Data to

date suggest that image density is more closely related to the amount of bare soil present on the range site than species composition or vegetative cover (both live and dead).

Forage density data is obtained at present by clipping all above-ground vegetation from a 1 square meter plot selected from within the range site. Fresh weight and oven dry weights are recorded for each sample. This data then represents total vegetative biomass for the site. Vegetative survey data can then be used to calculate that portion of the total biomass which represents usable forage. As expected, forage density is a direct reflection of the percent ground cover represented by live vegetation determined by the vegetative survey.

Additional documentation in the form of 35mm color and color infrared photographs are also taken at the time of site evaluation, as well as periodically throughout the growing season. This photography is an attempt to correlate the onset and decline of infrared reflectance to the physiological state of the vegetation present on the range site. Since high altitude aircraft color infrared film is analogous to the 35mm color infrared film, comparisons will be made of air and ground photos taken at approximately the same time. Currently under consideration are some anomalies as to ground detection of infrared reflectance as opposed to non-detection of infrared reflectance from high-flight aircraft for the same area taken within 3-5 days of ground photography.

#### ERTS Evaluation for Forage Density

Of the individual wavebands studied, MSS band 5 appears to yield the most information with regard to forage density. Image 1025-16554 showed approximately a 0.1 optical density unit difference





show that the subirrigated-wetland range sites can be readily separated from other range sites, due primarily to their reddish color. This site combination delineates the soil subgroups Aquic Haplustolls and Typic Haplaquolls from other soil subgroups present in the sandhills. Color tone differences of the other site categories are more subtle and may require the use of a single waveband of the visible spectrum as a light source in densitometer evaluation for maximum differentiation of sites. Photographic manipulations are necessary to utilize projector-viewer generated color composites. Difficulties in registration of imagery plus the decrease in detail through photographic manipulation make the use of the projector-viewer less helpful than we had anticipated.

Diazochrome color composites have proven to be the more versatile of the methods attempted for study of ERTS imagery. Since this is essentially a contact print process, loss of detail appears to be minimized. Projection of the resulting composite generally results in less loss of detail than experienced in photographing projector-viewer generated images. Less registry problems are also encountered with the diazochrome overlays. By variation of exposure times for individual wavebands much the same effect can be created as varying the intensity of the light source on the projector-viewer. Availability of a range of colors of diazochrome suggests the possibility of color enhancement in other than the standard filter colors of the projector-viewer.

Evaluation of color composites made by the diazochrome process show the subirrigated-wetland sites to be easily distinguishable, resulting in the same delineation of Aquic Haplustolls and Typic

Haplaquolls as previously mentioned. Ease of production, projectability and an immediate permanent record are distinct advantages which will make the technique relatively useful.

#### Lake Water Quality Evaluation

Reflectance differences shown by Sandhills lakes in Cherry County on MSS bands 6 and 7, image 1025-16554, are being evaluated. Water samples taken by Nebraska Game and Parks Commission personnel are being analyzed by the Department of Agronomy water quality laboratory. Analysis of water samples to date would indicate that the greater the total amount of molecular ions present in the water, the greater the amount of reflectance from the body of water. Of the lakes sampled, Willow lake, which has the greatest amount of reflectance has the greatest total amount of dissolved ions present in its water. The greatest contribution to the ion total for Willow lake was bicarbonate ion.

Additional documentation in the form of observational notes and color and color infrared photography is also being gathered. This documentation is an attempt to relate any possible reflectance differences to emergent and/or submergent aquatic vegetation. Water quality obviously will influence kinds and quantities of aquatic vegetation present in the lakes. The evaluation should indicate if the vegetation is playing any role in the overall reflectance of the lakes.

Densitometer measurements of lake images on MSS bands 6 and 7 indicate differences in reflectance of the Cherry County lakes on both bands. Arbitrary division of optical densities for band 7 was into two groups, 0.64 to 1.17 and 1.50 to 1.70. For band 6, arbitrary division was into three groups, 0.62 to 0.81, 1.01

to 1.14 and 1.25 to 1.36. Data are not complete enough at this time to suggest water quality parameters which result in these groupings.

#### Winter Imagery Evaluation

Winter imagery with snow cover and low sun elevation show a marked enhancement of dune patterns. Topographic changes in landscape or frequency of dune pattern are most evident. Features such as depressions along the larger dune ridges and breakup of the typical large regular dune pattern into smaller randomly placed dunes are easily distinguished. Comparison of MSS band 5 summer imagery and the identical area under snow cover shows that where major dune patterns are subdivided into smaller random dunes, forage density is significantly less and there is a much greater proportion of active wind erosion. The relationship of range management and topographic expression within these subdivisions of major dunes to decreased forage density is under investigation.

#### Great Plains Corridor Cooperation

Data gathering for the Great Plains Corridor project (MMC 667) at Texas A&M University was begun in April. Ground photography plus forage clipping data were taken at the approximate time of each satellite overpass. Data will provide an indication of total biomass change with progression of the growing season and forage density change due to grazing on those sites which are being grazed. Ground photos will indicate color and color infrared reflectance changes which occur throughout the growing season.

#### Aircraft Photography Evaluation of "Go-Back" Land

Initial evaluation of high altitude aircraft color infrared photography shows that previously tilled areas of the sandhills

which have been abandoned since the early 1900's can be recognized on the photography. These abandoned tilled areas, which were attempts at homesteading the land, are commonly called "go-back" land. Attempts are currently being made by the Soil Conservation Service to accurately assess the extent of these "go-back" lands and plan some type of renovation program to return these lands to optimum forage production. Because of climatic conditions this "go-back" land has not reverted to native grasses very rapidly. A general estimate is that renovation will increase forage production four fold. Since the total area of "go-back" land is over 500,000 acres, this represents a sizeable potential increase in forage production for the Sandhills as a whole.

#### Program For Next Reporting Interval

The program for the next six-month period will essentially be a continuation of efforts in the areas discussed in the foregoing paragraphs. Ground truth data will continue to be collected. Vegetative and ground cover data will be obtained, as well as descriptions of soil profiles for the sites under study. Forage density will be measured on the sites also, in the form of clipping data.

Both individual wave band and color composite imagery will continue to be evaluated for estimation of forage density. Density slicing will be attempted with band 5 of the MSS imagery to evaluate large area interpretations of forage density interpretations made thus far. Continued use of color composites, primarily in the form of diazochrome images, will be made for evaluation of additional soil mapping unit delineation and forage density interpretation.

Water samples will continue to be taken and analyzed for interpretation of reflectance differences among the Sandhills Lakes. Additional documentation in the form of observational notes and color and color infrared photography will be taken to evaluate the role of aquatic vegetation in the reflectance response.

Winter snow cover imagery will continue to be evaluated with regard to features of the Sandhills which can be related to topographic change. Certain aspects of soil association maps may possibly be delineated, especially in conjunction with imagery showing vegetative patterns. Subdivisions of the topographic expression of dunes as related to decreased forage density will be studied further.

Collection of ground truth data and photographic documentation will be continued in cooperation with the Texas A&M Great Plains Corridor Study.

Evaluation of high altitude aircraft photography will be made for interpretation of "go-back" land. Ground truth will be gathered to ascertain recognition, accuracy of acreage measurement, and reliability of plant cover evaluation.

#### Conclusions

Ground truth indicates that delineation of range sites and the relationship of vegetative patterns to associated soils is primarily a function of the percent base soil present and the relative vigor of the vegetation growing on the study area (indicated by infrared reflectance). It is feasible to make some estimate of forage density on band 5 of MSS imagery provided the identification of the range site category is known. Color composites of imagery provide the supplemental dimension of color, as provided by infrared reflectance, as an aid in interpretation of relationships

